Overview of Scientific Aspects of Spatial Cognition: Significance in Architectural Design

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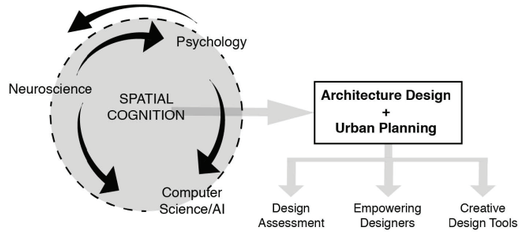
I. EXTENDED ABSTRACT

I.I. Summary

In order to understand the implications of spaces on human behavior and vice versa, it is first imperative to understand the process of spatial cognition and its computation in the human brain. Spatial cognition is an essential aspect of our social behavior in different spaces and also plays an elemental role in our spatial perception, psychology and memory. However, the merits of understanding spatial cognition are not limited to fields of neuroscience and social sciences, but also extend to architecture and urban planning. In this paper, I argue that it is essential for architects to understand various scientific aspects of spatial cognition in order to design spaces that invoke the spatial experience intended by the designer. Further, I investigate the current literature on various aspects of human spatial cognition and highlight the implications of these findings in the process of spatial design and planning. I also summarize the different computational models of the cognitive process developed for applications - such as robotic exploration in unmapped regions and for human interactive interfaces. The paper concludes by proposing a framework, which is predominantly driven by spatial cognition, and aims to redefine the modality of design and creative design pedagogy.



I.2. Scientific Aspects

Human beings, in addition to being social species, are also spatially sensitive in a significant way. Our spatial cognition apparatus, not only assists in spatial navigation and orientation, but also influences our emotions and associative memories. This cognitive process can be argued as being of multi-modal nature, as we perceive our environment through various senses – brightness, noisiness, smell, openness/ vastness, symmetry, repetition and other such design features. As we sense our environment through various modes, we also form a spatial representation of these places in our memory called the "spatial image"[Loomis, 2008]. This symbolic representation commonly forms an associative memory link between the senses and emotions – called as "place attachment" in psychology [Lewika, Maria, 2011], and often measured quantitatively in Psychometric and Likert scale. Scientist Nancy Kanwisher [2009] and her lab have successfully located the region in our brains called PPA – the parahippocampal place area, which responds not only to spatial environment, but also images of scenes and places. Her paper informs how this region is significant in tasks wherein humans rely solely on layouts of spaces (and not objects or landmarks) to reorient themselves in an environment after they are disoriented. The modes of encoding structured spatial information in human brain are mainly classified as egocentric and allocentric frames of reference [Pailiard, 1991]. Behavioral studies on the egocentric and allocentric cognition processes show that these mechanisms assist not only in our navigation ability, but also govern the levels of attention required for correct perception of spaces.

I.3. Relevance in Design

Architectural design and planning impose significant emphasis on properties of symmetry, axial orientation, sequential alignment, optimized placement, proximity and other such characteristics for building circulation, program placement, city planning, urban landuse etc. While most of these designs emerge from an intuitive understanding and knowledge of spatial experiences, I argue that a scientific basis of developing spaces – in particular user and use specific designs would go a long way in creating efficient solutions in varied ways (e.g., spaces for visually impaired, or university design focused to enhanced learning or city planning). As a designer, I maintain that there is a significant difference in concepts and processes of cognition of places and spaces. Places form the physical attributes of environmental information like location, orientation, etc. while spaces are embedded with abstract

information involving emotions, feelings etc. If we understand the process of acquisition of information of a physical place, its cognition by our innate cognitive apparatus and encoding of this perceptive information into our spatial memory, we can be better equipped to hack this process to create spatial environments that produce a seamless transition between place and space perception.

Architects and designers can also leverage the scientific observation of difference in attention demands (in different spatial environments) to instill the feel of awe and emphasis in creative architectural designs. By governing which aspects of spatial use can be designed as egocentric and which aspects can be forced to be allocentric we can quantitatively assess successful use of spaces designed by the architect for a particular purpose. Additionally, by measuring the accuracy of spatial updating while traversing through a given space using different modalities like sound, vision, touch or plain blind navigation, one can measure or compare performance and behavior of users of spaces. This aspect of spatial cognitive theory is crucial not only in defining success of architectural designs for users of varied disabilities, but also provides basis for framework of quantitatively assessing design space efficiency. Using this concept of spatial updating along with computational models of neurological cognition of users in space, designers can simulate and predict the user behavior in their specific designs and correct inefficiencies. These concepts can further be used to evaluate multiple iterations of design and can be coded into computational systems designed for user specific models.

I.4. Contributions

In conclusion, this paper shifts focus on significance of acquiring the scientific knowledge of spatial cognition from the different fields of neuroscience, psychology and computational science. The concept of creative intelligence is a significant one, and this paper suggests that the empirical interdisciplinary studies of spatial cognition would enhance the creative intelligence of designers especially in shaping environments.

2. REFERENCES

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3. AUTHOR BIO

Dishita Turakhia is an architect and computational researcher studying at MIT with interest in computation in creative design. Her current research focuses on using artificial intelligence (AI) to develop humanlike socially cognitive architectural systems.